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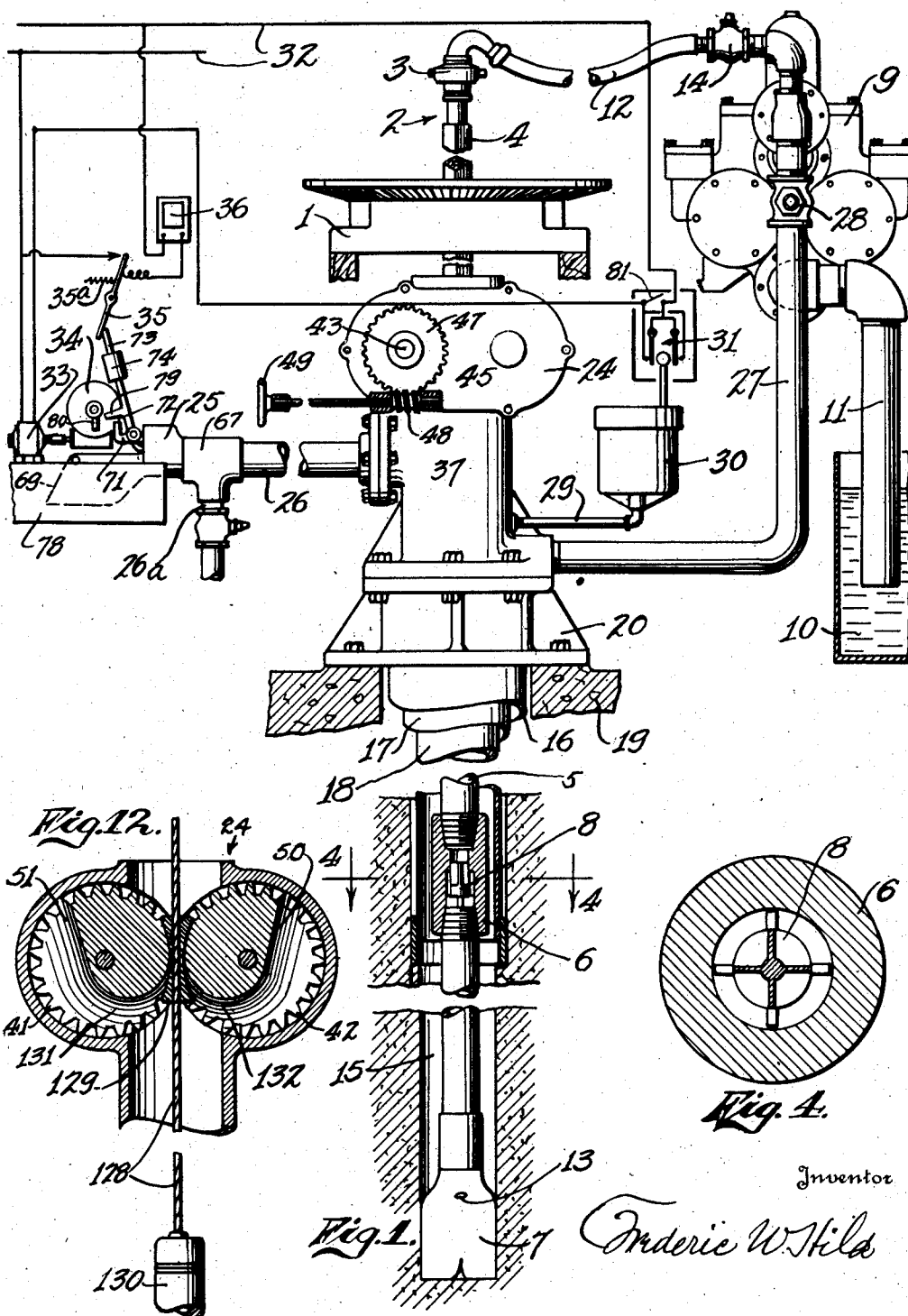
F. W. HILD

1,938,019

EQUIPMENT FOR BLOW-OUT PREVENTION

Filed Dec. 15, 1928.

4 Sheets-Sheet 1



Inventor

Fredrick W. Hild

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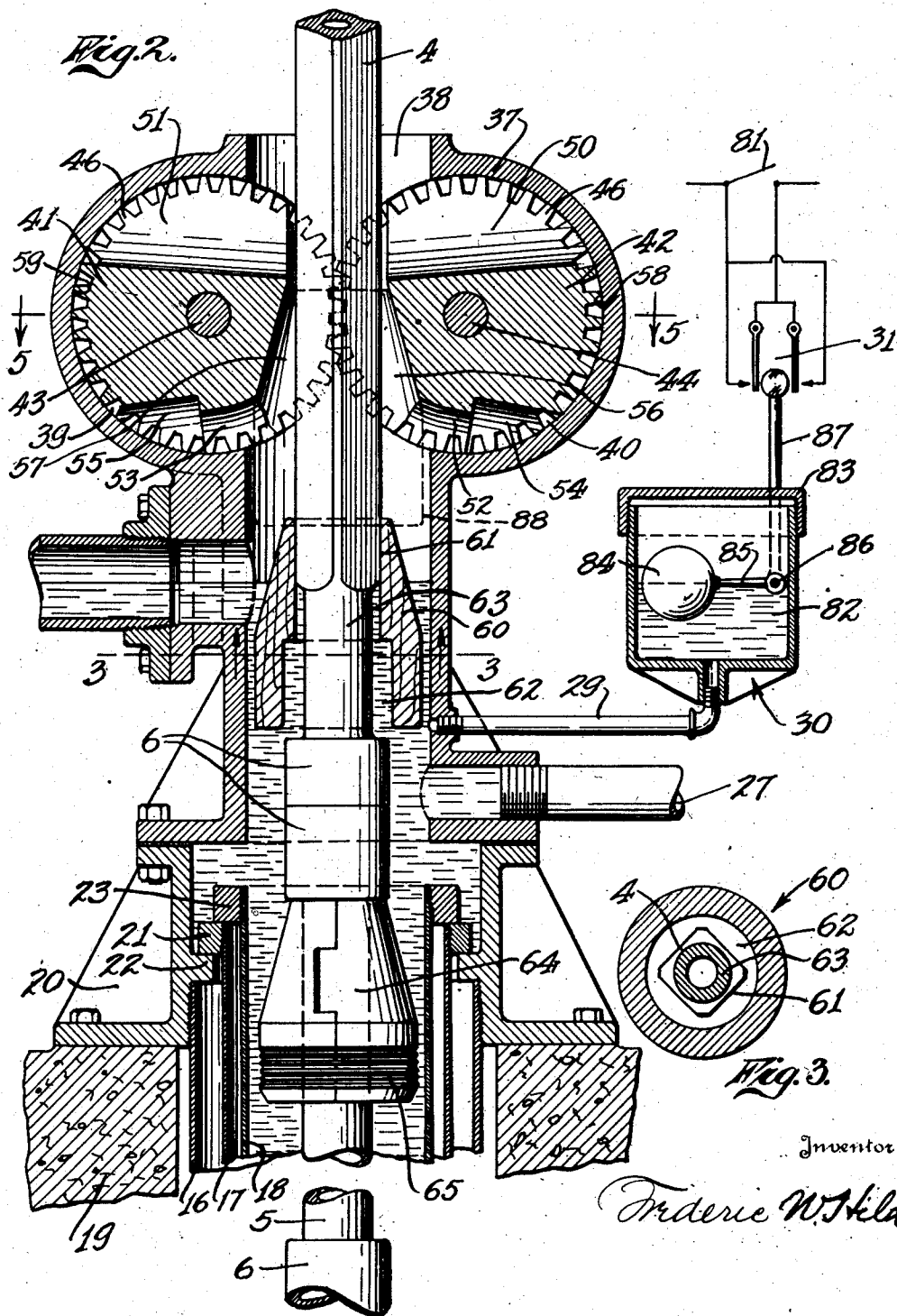
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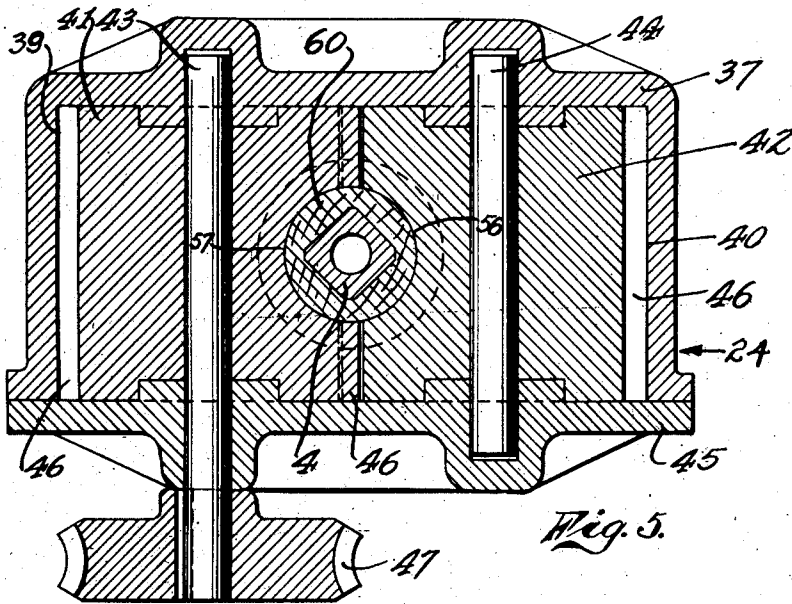


Fig. 5.

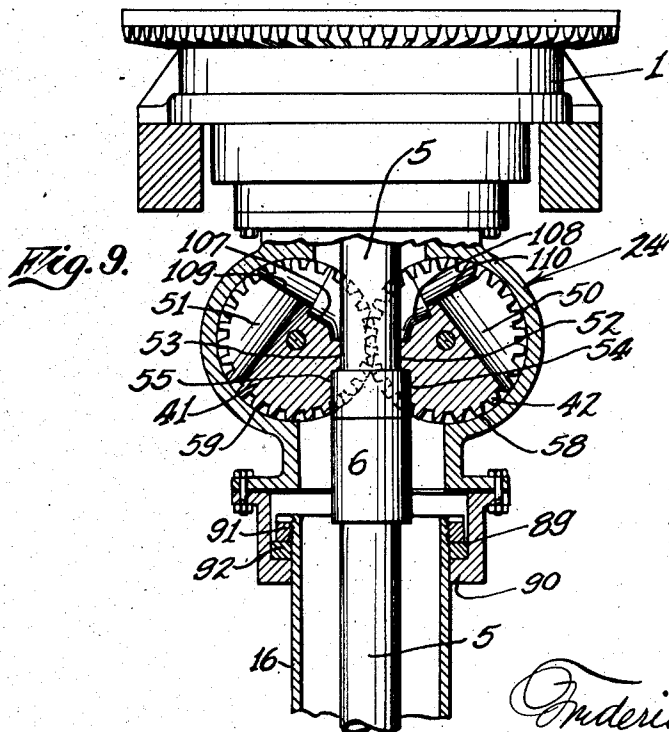


Fig. 9.

Inventor

Fredrick W. Hild

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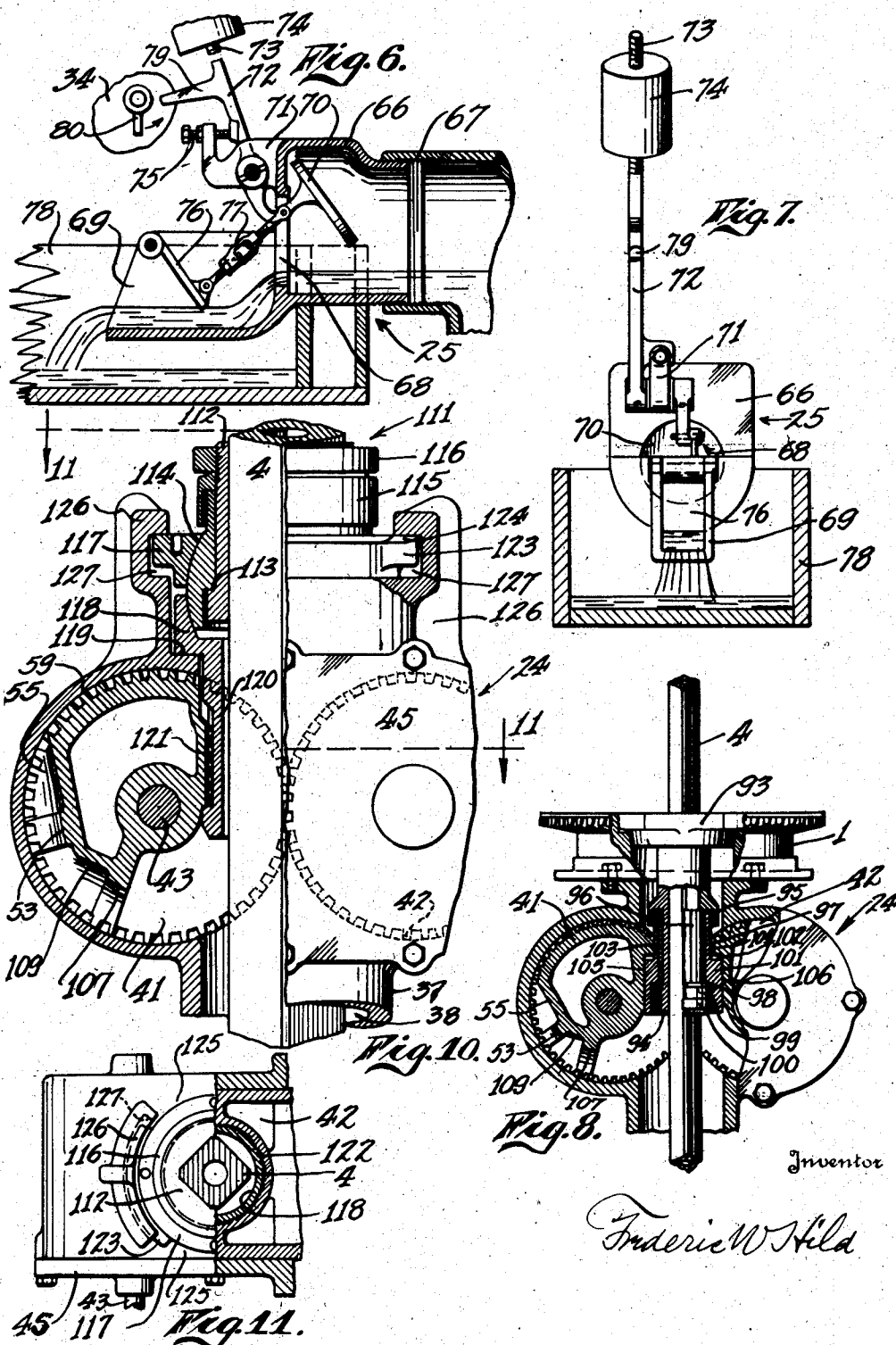
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Filed Dec. 15, 1928

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UNITED STATES PATENT OFFICE

1,938,019

EQUIPMENT FOR BLOW-OUT PREVENTION

Frederic W. Hild, Los Angeles, Calif.

Application December 15, 1928
Serial No. 326,208

20 Claims. (Cl. 255-1)

My invention relates to the hydraulic system of drilling used in the petroleum industry and appertains more particularly to equipment for preventing blow out of the fluids used and encountered in that system.

In this system a power driven rotary machine commonly rotates a hollow drill string consisting of a swivel head, a square or fluted drill stem, a drill pipe and a bit.

The swivel head is flexibly connected to a power driven hydraulic pressure pump, which forces mud fluid downward through the drill string, the mud discharging from the bit and returning upward outside the drill pipe and within the pipe or well casing which is inserted in the bored hole and usually cemented to the sides thereof. Suitable conduit connects the well casing with the mud pool which supplies the pump and the mud fluid is thus circulated.

Among its several important functions, the weight of the mud serves to counteract the underground fluid pressures due to gas or other fluids, so that with suitable mechanical means, the mud fluid may be utilized to control the flow and the pressure of the subterranean fluids.

The hydrostatic pressure of the mud fluid in the bored hole varies during drilling: on the one hand, if the mud circulation is maintained, the pressure increases as the drill cuts downward; on the other hand, the head and the pressure are subject to diminution from several causes.

When removing the drill string for any reason: the level of the mud column lowers, whereupon the hydrostatic pressure lessens correspondingly. This may be offset by pumping mud into the hole. Then, too, the mud density may diminish due to dilution when water strata having sufficient pressure are uncovered; this has the effect of lessening the hydrostatic pressure of the mud column. Furthermore, mud is "lost" by filtration into porous formations, or, when the drill opens an underground cavity. Interruption of the mud circulation by the drilling crew, or because of defective equipment is only occasionally of serious importance but may have disastrous consequence in emergency.

Obviously the hydrostatic pressure of the mud column should exceed the underground fluid pressures released by the drill, otherwise the mud will be forced upward together with the impelling fluid and both will escape through whatever openings may be available in the mud circulating system. Once the mud is thus started upward, its counteracting force diminishes more

rapidly than that due to the quantity ejected. This is because the effective head of the mud column is caused, not alone by the actual quantity of mud in the hole, but in addition thereto by another quantity equivalent to that displaced by the submerged portion of the drill string. Thus as the impelling underground fluid pushes the mud out of the hole, the counteracting force rapidly lessens, and the upward movement of both mud and fluid accelerates rapidly, especially if an expansible medium such as gas be present.

It is commonly recognized that most of the gas and oil well blowouts which became conflagrations, were ignited by particles of stone or other substance that were rendered incandescent by friction with the well casing or the suspended drill string while being ejected at tremendous speed by the escaping fluid.

Although high underground pressures have been encountered at comparatively shallow depths, it is manifest that the greater depths to which wells must be bored, mean higher pressures which unless adequately controlled, increase the hazard to persons and property. The suddenness, the rapidity and the other exigencies involved, demand automatic, quick acting control apparatus quite beyond mere reliance upon manual effort of the workmen. My invention provides methods and equipment which successfully meet the conditions and prevent blowouts in simple and effective manner.

Among the objects of my invention are to provide methods of controlling the ejection of the mud and the impelling fluid by utilizing the flow of the mud from the bored hole to effect timely and suitable closure of the mud discharge paths.

It is an object of my invention to provide in each of the several paths through which the mud and the underground fluid may be ejected—a device which shall automatically effect closure of each path when the pressure of the underground fluid begins to exceed that of the mud fluid.

Thus an object of my invention is to provide a self-acting discharge valve, which shall permit the free circulation and discharge of the mud fluid during normal drilling but which shall automatically close when the flow of the mud fluid through the valve exceeds a predetermined rate.

Another object of my invention is to provide a control device which shall automatically close the said valve when the mud fluid level in the bored

hole falls below or rises above predetermined limits.

Another object of my invention is to provide buoyant bushings on the drill string floatable in the mud fluid, and actuated by the mud fluid to effect closure of the upper end of the well casing in accordance with the excess of the underground fluid pressure.

Still another object is to provide a multiple casing valve secured to the well casing which without change of its parts may engage drill strings of different diameters and thereby effect closure of the well casing. Further objects are to effect closure by such a valve either with or without the drill string or the rotary machine; also to effect such closure at the drill stem, or at the drill pipe, or at a tool joint or at a rotatable member of the rotary machine such as the drive bushing.

Still another object of my invention is to provide a drill stem bearing bushing for effecting closure of the well casing which shall be self-centering and self-aligning and which may be positioned by the drill stem and secured in place without resorting to bolts.

In my co-pending application Serial Number 312,887 filed Oct. 16, 1928, I have described a means for effecting closure of the well casing by a rotary drilling machine in operative engagement with a drill string and flexibly secured in fluid-tight connection with the well casing. It is an object of my present invention to effect such connection by means of a valve rigidly secured to the rotary machine and a slip joint slidably connecting said valve with the well casing. Further objects of my invention are to provide a rotary drilling machine with a drive bushing adapted to be rotatably engaged by said valve so as to effect closure for preventing the ejection of fluid from the well casing, and also to prevent upward displacement of the drive bushing, thereby relieving the bearings and gears from the stresses and strains due to upward forces encountered during the drilling operations.

It is an object of my invention to provide equipment for fluid control and blowout prevention which may be interchangeably used with rotary drilling or cable tool drilling.

Other objects and advantages of my invention will be apparent from the following detailed description taken in conjunction with the drawings.

Figure 1 shows in vertical elevation and part section the application of my invention. Here are seen the rotary machine engaging the drill string which extends through a multiple casing valve and the well casing; also a tandem discharge valve for the mud fluid, a motor for the tandem valve, a fluid level box and the pump and the connections for the mud circulation.

Figure 2 is an enlarged view in vertical section of the multiple casing valve and the floating bushings on the drill string.

Figure 3 is a horizontal section taken on the line 3—3 of Figure 2.

Figure 4 is a horizontal section taken on the line 4—4 of Figure 1, through the back pressure valve in the drill string.

Figure 5 is a horizontal section of the multiple casing valve taken on the line 5—5 of Figure 2.

Figure 6 is a vertical section of the tandem discharge valve.

Figure 7 is an end view of the tandem valve shown in Figure 6.

Figure 8 shows in part vertical section the drive bushing of a rotary machine engaged by the multiple casing valve.

Figure 9 shows in part vertical section, the drill pipe engaged by the multiple casing valve; also the latter secured to the rotary machine and to a slip joint which connects with the casing.

Figure 10 shows a self aligning, self centering drill stem bearing seated on and engaged by the multiple casing valve.

Figure 11 is a horizontal view in part section taken on the line 11—11 of Figure 10.

Figure 12 is a part sectional elevation showing the application of my invention to cable tools.

Referring now to Figures 1 and 2, the rotary machine 1 engages the hollow drill string 2 which comprises the swivel head 3, the drill stem 4, the drill pipe 5, the tool joints 6, the bit 7 and the back pressure valve 8. The pump 9 draws mud from the supply pool 10 through the suction pipe 11 and forces the fluid through flexible hose 12 into swivel head 3 and down through the hollow drill string 2 emerging therefrom at the holes 13 in bit 7. A valve 14 at the pump controls the fluid flow through the hose 12.

One or more strings of well casing are inserted into the bored hole 15 such as the outer string 16, a second string 17 and a third string 18. Upon a suitable base or foundation 19 is mounted a casing clamp 20 which provides common support for suspending the several casings. The outer string 16 is threaded directly into the clamp 20. Casing 17 is threaded into collar 21 which rests upon the annular projection 22 of the casing clamp 20, while casing 18 is threaded into collar 23 which rests upon collar 21. Thus the casing clamp and the foundation support the casings against the downward pull due to their weight, and the combined casings oppose upward force which may be transmitted by the casing clamp.

Secured to the top of casing clamp 20 is the multiple casing valve 24 through which the drill string 2 may extend and be engaged by the casing valve as more particularly described hereinafter. Into the side of casing valve 24 below its gate members, is connected a pipe 26 to conduct fluid from the well casing to the tandem discharge valve 25 which is connected to the pipe 26. The by-pass valve 26a connected to the pipe 26 permits discharge of the fluid when the tandem valve 25 is closed.

Two other openings in the casing valve 24, below that for pipe 26, are provided for connection with two other pipes one of which namely, pipe 27, connects with the pump 9 at the plain valve 28 for conducting fluid from the pump into the well casing. The other pipe 29 connects the casing valve 24 with the fluid level box 30.

The fluid level box operates a double throw switch 31 which controls the electrical circuits from the power means 32 to the motor 33. This motor, acting through a suitable speed reducer 34, operates to close the tandem discharge valve 25 when the switch 31 is thrown to either of its contacts. The tandem valve upon starting to close, actuates switch 35 which closes the electrical circuits to energize a suitable signal device 36 which may be audible or visual or both.

Considering now the casing valve 24 and referring also to Figure 5, the body 37 has a vertical cylindrical opening 38 extending through the body, the axis of which lies in the drilling axis which is common to the rotary machine, the drill string, the casing clamp and the well casing. In the body 37, at right angles to the opening 38, are bored two cylindrical valve seats 39 and 40 for receiving two rotary valve gates 41 and 42 respectively, which may be mounted on the shafts

43 and 44 respectively. The shafts are journaled in the body 37 and in a side cover plate 45 which is tightly secured to the body so as to enclose and seat the rotary gates. On the cylindrical, circumferential surfaces of the rotary gates are formed gear teeth 46 which mesh; so that rotation of one gate compels rotation of the other gate in the opposite direction. The faces of the gear teeth and the sides of the rotary gates contact the surfaces of the valve seats and substantially prevent fluid flow past the contacting surfaces. The shaft 43 projects outwardly from the valve body or side cover plate in order to receive a suitable means for rotating and locking the gates 41 and 42 into position. Such a means is an irreversible worm gear transmission indicated by the worm gear 47, its worm 48 and the hand wheel 49 on the extension of the worm.

In order to pass a bit or other large object through the valve into the well casing, a semi-circular opening shaped like a half cylinder and having radius equal to that of opening 38 is formed in each rotary gate. Such a semi-circular opening is 50 in rotary gate 42 and also 51 in gate 41. When the two gates are rotated, the axis of opening 50 approaches the axis of opening 51 until they coincide with each other and then they will also coincide with the common drilling axis, whereupon the full valve opening is made. Similarly, smaller openings 52 and 53, having radius equal to the radius of drill pipe 5, and likewise openings 54 and 55 having radius equal to the radius of the tool joint 6, are formed in gates 42 and 41 respectively. Also, and in like manner, the gates 42 and 41 have the tapered openings 56 and 57 respectively, which form a truncated cone when centered in the drilling axis. The remainder of the cylindrical toothed surfaces of the rotary gates, indicated by the arc 58 on gate 42, and by the arc 59 on gate 41, provide closure of the valve when the arcs are tangent to the drilling axis. When lowering the drill string 2 through the casing valve 24 into the well casing, a buoyant bushing 60 is slipped on the drill stem 4 before the latter is connected to the drill pipe. The bushing 60 is of wood or other material constructed to float on the mud fluid in the well casing. A hole 61 fitted to the square shape of the drill stem, extends axially through the bushing from its upper end, to a larger cylindrical bore 62 at the lower end. The bore 62 has diameter sufficient to provide bearing fit on tool joint 6. The lower portion 63 of the drill stem 4 is round having diameter equal to the square side of the drill stem, so that when the bushing 60 surrounds the lower portion 63 of the drill stem, the bushing may serve as a bearing in which the drill stem 4 and the tool joint 6 may rotate; this is shown in Figure 3. When, however, the bushing 60 is above the round portion 63, the square part of the drill stem is in hole 61 and the bushing must rotate with the drill stem. The upper outer portion of the bushing 60 is tapered and shaped like a truncated cone in order to fit into the tapered conical opening 56 and 57 of the rotary gates 42 and 41 respectively. The lower outer portion of the bushing is cylindrical having diameter less than that of opening 38 of the valve 24.

A buoyant bushing 64 of like floating material as bushing 60 may be placed on drill pipe 5. Bushing 64 is bored for bearing fit on the drill pipe and is also split vertically into two parts. Suitable means such as wire wrapping 65 serve to hold the two parts together on the drill pipe. Referring to Figures 1, 6 and 7, the tandem

valve 25 has a body 66 which is connected by the coupling 67 to the pipe 26. Fluid from the pipe flows through the body and discharges from the opening 68 into a weir 69 which extends from the body 66 and is an integral part thereof.

Change of the rate of flow of the fluid through the body 66 and the opening 68 is reflected in corresponding change of fluid level in the weir 69 which having a relatively narrow channel multiplies the apparent change. Inside the body 66 is the valve gate 70 which is hung on the support 71 projecting outside the body. The gate is counter-balanced by the arm 72 and by the weight 74 which is adjustably positioned on the threaded extension 73 of the arm 72. An adjusting screw 75 adjustably fixes the open position of the gate 70. A weir gate 76 is hung in the sides of the weir so that it may swing in the flow channel thereof. The valve gate 70 and the weir gate 76 are adjustably connected to each other in tandem by the turn buckle 77. The tandem valve 25 is supported by the trough 78 into which the fluid from the valve is discharged, and which conducts the fluid to the mud fluid supply 10.

When the valve gate 70 is positioned for maximum valve opening by the adjusting screw 75, the weir gate 76 is adjusted by the turnbuckle 77 to the position of normal fluid flow through the weir. Should the flow increase above this limit, the fluid level will rise in the weir channel, the flow will exert pressure against the weir gate 76 causing it to swing downward, whereupon the pressure on the weir gate and its movement are accelerated; meanwhile the force acting on the weir gate is transmitted by the turn buckle 77 to the valve gate 70 thereby moving the latter to effect closure of opening 68. When the valve gate encounters the flowing fluid, the pressure of the fluid is exerted against the valve gate accelerating its movement to complete closure.

The switch 35 is normally held closed by the spring 35a. When the tandem valve 25 is in the normal flow position the counterbalance arm 72 and its extension 73 opens the switch 35. But upon the first movement of the valve gate 70 toward closure, the arm 72 and extension 73 being also moved away from the switch, permit the latter to close, thereby energizing the circuits to the signal device 36 which then operates and apprises the workers at the very beginning of the fluid rise.

The tandem valve may be operated by a suitable power means. Thus the counterbalancing arm 72 has a projection 79 which is adapted to be engaged by the motor actuated cam lever 80. This cam lever is secured to the low speed shaft of speed reducer 34 which is driven by motor 33. A switch 81 in the power supply and motor circuit is available to the driller for energizing the motor to drive through the speed reducer, to the cam lever 80 which upon being rotated, engages the projection 79, forcing the counterbalancing arm and the valve gate 70 into the closed position of the tandem valve.

The fluid level box 30 comprises the fluid box 82 and its cover 83, within which are the float 84 and its lever 85. The float lever 85 is secured to the shaft 86, one end of which projects outwardly from box 82 in order to be secured to the switch lever 87 which operates to close the double throw switch 31 whenever the float 84 is raised by the fluid in the box to a predetermined level, and likewise whenever the fluid is lowered to another predetermined level. Upon closing the switch 31 to either of its contacts, the motor 33 is energized

to operate thereby causing the tandem valve 25 to close.

The simple, automatic operation of the system described is evident. During normal drilling, the mud fluid after being forced down the drill string 2, discharges from the bit 7 at the bottom of the hole, and flows upward between the drill string and the inner well casing through the casing clamp 20, to the lateral openings in the casing valve 24, into which are connected the pipes 27, 29 and 26. The valve 28 in the pipe 27 is closed except as hereinafter stated. The fluid rises in pipe 27 and in the fluid level box 30 to the common level of normal flow through pipe 26 and the tandem valve 25.

The buoyant bushing 60 which normally is on the square part of the drill stem 4, will rotate with the latter in the mud fluid, but the bushing because of its buoyancy, will float on the fluid as the drill stem moves up or down. The bushing 64 in which the drill pipe 5 may rotate, is submerged but because of its buoyancy the bushing 64 will bear against the tool joint 6 above it.

When the bit releases underground fluid having sufficient pressure to overcome the weight of the mud column in the hole,—the mud fluid level will rise in the casing valve 24, in the pipe 26, in the tandem valve 25 and in the fluid level box 30; likewise, the bushing 60 will rise. At the same time the mud flow through pipe 26 and the tandem valve 25 will increase and thereupon, the tandem valve will be closed by the flowing mud and the signal device 36 will warn the drilling crew as previously explained. But one outlet, the casing valve 24 remains available for the escape of the mud fluid, which rising in the valve, carries with it the bushing 60 and forces the latter into the seat formed by the conical openings 56 and 57 of the rotary gates 42 and 41 respectively; whereupon closure is effected. This is indicated by the broken line 88 in Figure 2.

Warned by the signal, the driller will have ample notice to begin increasing the density of the mud fluid and to either stop the rotary machine or else to hoist the drill string until the round portion 63 of the drill stem 4, is within the bushing 60, thereby enabling rotation of the drill string, while "circulating" the mud fluid through the by-pass valve 26a.

If, instead of encountering high underground fluid pressure, the bit had opened a cavity into which the mud fluid could flow, and substantially lessen the level of the mud column in the casing,—then the float 84 in the fluid level box 30, responding to the lowered level, would cause the switch 31 to close thereby energizing motor 33 which thereupon would close the tandem valve 25 and operate the signal device 36, warning the driller to stop drilling and to replenish the mud column.

The lowered fluid level would allow the bushings 60 and 64 to descend to the next tool joint below each respectively. Should the driller persist in drilling deeper with inadequate mud column and release excessive underground fluid pressure,—then the resultant rise of fluid would be impeded first by bushing 64 and then by bushing 60. The bushing 64 would rise to the tool joint above it and then the weight of the drill string would oppose its further rise. The bushing 60 would be forced into its seat in casing valve 24 whereupon the outlets would be closed. If the pressure be sufficient to lift the drill string, the latter could move upward only the short distance from the tool joint to the

bushing seated in the casing valve; then the combined weight and resistance of the several casings and the drill string would oppose the upward fluid pressure and further upward movement of the drill string.

When removing the drill string to change bits or the like, during a condition of near equilibrium of the opposing fluids in the hole, the first lowering of the fluid level due to removal of the drill stem or a length of drill pipe will cause the tandem valve to close, as before explained. The driller will replenish the mud column by pumping mud fluid through pipe 27 into the well casing; and when the bushing 64 is removed, the driller may rotate the casing valve gates until the openings 52, 53, 54 and 55 have their axes in the common drilling axis. In this position, which is illustrated in Figure 9,—upward movement of the drill pipe is opposed at the tool joint by the casing valve gates and substantial closure is then effected. Tendency of the fluid to rise or escape through the drill pipe is opposed by the back pressure valve 8.

Figures 8 and 9 show the casing valve 24 secured directly to the rotary machine 1 and secured flexibly to the well casing by means of slip joint 89. The slip joint has annular projection 90 which fits slidably on casing 16. A collar 91 threaded on to the casing bears against packing 92 which is within the slip joint and resting on projection 90. Thus the rotary machine and the casing valve may move downward to a limited extent but upward displacement is prevented by the slip joint and the well casing.

The rotary machine of Figure 9 may be such as described in my aforesaid co-pending application Serial No. 312,887, but in Figure 8, the drive bushing 93 of the rotary machine 1 has an extension 94 with an overhanging annular mud deflector 95. The extension 94 below the shoulder of the mud deflector 95 is journaled in split bearings 96 which are held in place by sleeve 97 surrounding the split bearings and by the washer 98, and the two jam nuts 99 and 100 on the threaded lower end of extension 94. The sleeve 97 has an annular extension 101 surrounding the washer and jam nuts and forming the shoulder 102. The mud deflector 95 serves to deflect downward moving mud or other foreign substances from the split bearings 96 and sleeve 97, while the sleeve 97 serves a like purpose for the bearings, the washer and the jam nuts. Lubricant may be supplied to the bearings and the journal surface of the drive bushing 93 by grease gun pressure applied to a suitable duct from the top of the drive bushing.

The sleeve 97 is held firmly by the casing valve 24 so as to prevent its rotation and upward displacement. This is accomplished by rotating the valve gates until their openings 103 and 105 in gate 41, and 104 and 106 in gate 42 have their axes in common drilling axis. In this position, the valve gates 41 and 42 closely fit the outer cylindrical surfaces of the sleeve 97 and its extension 101 and when the drill stem 4 is in the drive bushing 93, closure of the casing valve 24 is effected and the rotary machine drive bushing is rotatably secured by the casing valve 24 so as to prevent its upward displacement.

Frequently more than one size (diameter) of drill pipe and tool joint are used in boring the same hole. The casing valve 24 provides for this by the openings 107 and 109 in valve gate 41 and by openings 108 and 110 in valve gate 42. These openings are additional and similar to

openings 52, 53, 54 and 55 previously described and are for use with another size drill pipe and tool joint.

The drill stem bearing 111 comprises the journal bushing 112 through which extends axially a square hole slidably fitting the square drill stem 4. The lower end of the bushing is larger in diameter than the upper portion with which it forms the shoulder 113. The bushing 112 acts as a journal for the drill stem and rotates in the self-aligning radial and thrust bearing 114, the thrust being at the shoulder 113. The upper end of bushing 112 is threaded to receive mud deflector 115 and jam nuts 116; the mud deflector forming an annular ring projecting down over the cylindrical outer surface of bearing 114. The lower portion of the bushing is spherical and fits in the spherical bearing seat formed by the upper block 117 and the lower block 118. The block 118 rests on the annular seat 119 of body 37 of the casing valve 24. The lower portion 120 of the block 118 projects downward into the openings 121 and 122 of the valve gates 41 and 42 respectively which lock the block 118 firmly against rotation and axial displacement.

The block 117 has radially projecting tongues 123, the upper faces 124 of which are at a comparatively small angle with a plane perpendicular to the common drilling axis. When lowering the assembled drill stem bushing 111 into the casing valve, the tongues 123 are first inserted in the slots 125 formed by the circular brackets 126 on the body 37 of the casing valve 24. Then the block 117 is rotated a few degrees thereby moving the tongues 123 into the grooves 127 which are extensions of the slots 125. The underfaces of the grooves 127 have the same tapered angular relationship as the faces 124 of tongues 123, the arrangement of the slots, grooves and tapered faces forming a breech lock, so that as the block 117 is rotated it is forced downward thereby applying pressure to the spherical portion of bearing 114 which in turn transmits the pressure to the lower block 118; the result being firm, tight, secure seating of the two blocks and the spherical bearing as among themselves, and the drill stem bearing as a whole in the upper body portion of the casing valve 24. Lateral clearance between the circular brackets 126 and the blocks 117 and 118 together with the spherical seating of the bearing in the blocks enable the drill stem bearing 111 to be self aligning and self centering with respect to the drilling axis. When the drill stem bearing 111 is firmly seated and secured in the casing valve 24 as described, the casing valve is closed to fluid flow which must then discharge from the lateral opening connected with pipe 26.

In Figure 12 the wire line 128 passes through a guide packing bushing 129 and may be secured to a string of cable tools 130 or to a bailer when removing the mud fluid. The gates 41 and 42 of the casing valve 24 engage the bushing 129 and thereby effect closure of the valve and of the casing outlet. The opening 131 in gate 41 and the opening 132 in gate 42 may be generated in the following manner: consider a cone shaped milling cutter (not shown) having its pointed end in the valve center which is the point of tangency of the drilling axis and the two gates, and its base below, rotating in the drilling axis. Then by feeding the cutter upward through the common center and simultaneously rotating the two gates such that gate 42 moves clockwise through about 90 degrees,—then the resulting valve opening in the common center is a circle

gradually increasing in diameter from zero (valve closure) to the maximum valve opening 50—51 formed by the gates 42 and 41 respectively as previously explained.

It will be noted that fluid flow through the casing valve 24 and the tandem valve 25 is always in the one direction and the valves function to close automatically with the same direction of pressure and flow. The back pressure valve 8 in the tool joint 6 is unaffected by increase or decrease of fluid flow or pressure in the normal direction down the drill string; but functions to close automatically when the pressure and the flow are reversed.

Although I have described several specific embodiments of my invention, it will be obvious to those skilled in the art, that various modifications may be made in the details of construction, the general arrangement, the association of the several co-operating parts and the application of my invention without departing from the spirit thereof or the principles herein set forth.

I claim as my invention:

1. In equipment for preventing blow out of fluid from a well, the combination of: well casing, a casing valve connected thereto; a drill string extending through said valve, and means slidable on said drill string concentrically interposed between said string and said valve for controlling the valve opening.

2. In blow out prevention equipment, the combination of: a casing valve, and means concentrically disposed within said valve comprising a revolvable member slidable on a rotary drill stem for controlling said valve.

3. A control head for well casing, having an opening, and a buoyant member floatable in mud fluid, and slidable on a drill string for closing said opening.

4. An automatic valve having two gates connected in series and counterbalanced for normally open valve position, one of said gates being positioned to initiate the closing of the valve by the other gate, either upon increase of the fluid flowing through the valve, or upon rise of the level of said fluid.

5. A casinghead having an outlet for conducting fluid from a well, and a member floatable in said fluid for engaging said outlet when the level rises.

6. A casinghead, a plurality of gate members adjustable to form any of a plurality of different configurations of axial openings for conducting fluid from a well, and supported on the casinghead, and a member floatable in said fluid and conforming with at least one of said configurations to close the outlet from the well.

7. In equipment of the character described, well casing, a valve connected thereto, a drill string extending through the valve, and a floatable closure for the valve slidable on the string, for controlling the valve opening.

8. A casinghead having a lateral discharge opening, a weir leading from said opening, a closure for the opening, a gate for the weir, and a connection between the closure and the gate.

9. A casinghead having a lateral discharge opening, a closure for said opening, and means responsive to a variation of liquid level beyond definite high and low points for moving said closure to close the opening.

10. A casinghead having a lateral discharge opening, a weir leading from said opening, a closure for the opening, a gate for the weir, and means whereby an increase of liquid in the weir,

acting on the gate, responsive to an increased rate of flow of liquid, closes the valve.

11. A casinghead having a lateral discharge opening, a weir leading from said opening, a closure for the opening, a gate for the weir, a connection between the closure and the gate, means urging the valve to open position and through the intermediary of the connection, also urging the gate out of the path of the liquid passing through the weir, and a motor for moving the valve to close the gate.

12. In a well drilling system which circulates mud fluid or its equivalent to counteract the pressure of underground fluid, a weir into which the fluid discharges, and a valve mechanism cooperating with the weir to stop the flow when the fluid level in the weir reaches a definite level.

13. A casinghead for a well, said casinghead having an outlet, means for circulating mud fluid or its equivalent in the well, and means for closing the outlet, said closing means including a member actuated by a variation in the rate of fluid flow from a desired rate for moving the closing means to closed position.

14. A casinghead having an outlet, a closure for the outlet, and means actuated by an increase in the rate of flow of fluid circulating in the well, above a desired maximum rate, for initiating the operation of the closure.

15. A casinghead having an outlet for conducting fluid from a well, a member floatable in said fluid for engaging said outlet when the level rises, and a guide extending through said member for accurately positioning said member with respect to the opening.

16. A casinghead having a lateral and an axial outlets for controlling fluid flow from well casing, closures for both of said outlets, and means

responsive to a rise in level of the fluid for actuating one of said closures to close the corresponding outlet, the other closure incorporating means whereby the operation of said one closure, causes the other closure to close its outlet.

17. A casinghead having a lateral and an axial outlets for controlling fluid flow from well casing, closures for both of said outlets, and means responsive to abnormal conditions in the flow of the fluid, for actuating one of said closures to close the corresponding outlet, the other closure incorporating means whereby the operation of said one closure, causes the other closure to close its outlet.

18. A control head for well casing, including a housing, adjustable means in said housing for controlling an axial opening through said housing, and means for adjusting said means so that it may optionally operate to close the opening in cooperation with either a round drill pipe or a bushing surrounding an angular faced drill stem, or for closing said outlet in the absence of either the pipe or the stem.

19. A control head for well casing, comprising means forming a taper bored seat converging upwardly from the well casing and forming an axial opening through which a drill string is adapted to extend, and a correspondingly tapered packer slidable with respect to the drill string and of unitary construction.

20. A valve having two rotatable gates, each of said gates having a plurality of stepped surfaces, and means for simultaneously operating said gates for causing the corresponding surfaces of the gates to define valve openings of different forms.

FREDERIC W. HILD.

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